

# Object-Oriented Design and Programming Tutorial

Consider the following simplified description of data storage arrays:

- A **data storage array** is made up of up to **12 storage devices**, each of which has a particular storage capacity (in GB), **data transfer bandwidth** (in MB/s) and latency (in milliseconds). Storage devices within a data storage array are usually, but not always, identical. When first created, a data storage array contains no storage devices; however, **storage devices can be added to it at any time**.
- Storage devices are either **Hard Disks (HDs)** or **Solid State Disks (SSDs)**. HDs have an **associated average rotation time** (in milliseconds) and an **average seek time** (in milliseconds). Latency for HDs is calculated as the **sum of the average rotation and seek times**. SSDs have an **associated average access time** (in milliseconds). Latency for SSDs is simply the average access time.
- **Data storage arrays** aggregate their **component storage devices** into one logical storage unit according to one of two configurations: **RAID 1** (which uses data mirroring) and **RAID 5** (which uses distributed parity).
- A data storage array has an effective **capacity**, **bandwidth**, and **latency**. Latency for a data storage array is given by the maximum latency of any of its component storage devices. **The effective capacity (resp. bandwidth) of a RAID 1 array is half the sum of the capacities (resp. bandwidths) of the component storage devices**. **The effective capacity (resp. bandwidth) of an  $n$ -device RAID 5 array is  $(n - 1)/n$  multiplied by the sum of the capacities (resp. bandwidths) of the component storage devices**.

- a Draw a UML class diagram to describe the above.
- b Write C++ class declarations (i.e. no function bodies) to support the above.
- c Write a test function as follows:
  - A RAID 1 disk array is created, and populated with 4 identical HDs. Each HD is a 500GB drive with an average seek time of 8ms, an average rotation time of 4ms and a bandwidth of 100MB/s.
  - A RAID 5 disk array is created, and populated with 4 identical SSDs. Each SSD is a 30GB drive with an average access time of 0.01ms and a bandwidth of 300MB/s.
  - The bandwidth and latency of the RAID 1 system is calculated.
  - The effective capacity of the RAID 5 system is calculated.
- d Write the bodies of the functions from part (b) that relate to your classes that represent storage devices and storage arrays.